Net-Centric Implementation Framework

Part 1: Overview

Part 2: ASD(NII) Checklist Guidance

Part 3: Migration Guidance

Part 4: Node Guidance

Part 5: Developer Guidance

Part 6: Acquisition Guidance

V 1.3

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Net-Centric Enterprise Solutions for Interoperability (NESI) is a collaborative activity of the USN PEO for C4I and Space, the USAF Electronic Systems Center, and the Defense Information Systems Agency.

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1 NESI Implementation

The NESI Net-Centric Implementation Framework document set consists of six parts. Some of the introductory information contained in this section of Part 1 is included in Parts 2-6; however, Part 1 contains a more complete overview.

1.1 References

(a) DoD Directive 5000.1, *The Defense Acquisition System*, 24 November 2003.

(b) DoD Instruction 5000.2, *Operation of the Defense Acquisition System*, 12 May 2003.

(c) DoD Directive 8100.1, *Global Information Grid (GIG) Overarching Policy*, 21 November 2003.

(d) DoD Directive 4630.5, *Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)*, 05 May 2004.

(e) DoD Instruction 4630.8, *Procedures for Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)*, 30 June 2004.

(f) DoD Directive 5101.7, *DoD Executive Agent for Information Technology Standards*, 21 May 2004.

(g) *DoD Global Information Grid (GIG) Architecture, Version 2.0*, August 2003.

(h) *DoD Architecture Framework (DoDAF), Version 1.0*, 9 February 2004.

(i) *DoD Net-Centric Data Strategy*, DoD Chief Information Officer, 9 May 2003.

(j) CJCSI 3170.01E, *Joint Capabilities Integration and Development System*, 11 May 2005.

(k) CJCSM 3170.01B, *Operation of the Joint Capabilities Integration and Development System*, 11 May 2005.

(l) CJCSI 6212.01D, *Interoperability and Supportability of Information Technology and National Security Systems*, 8 March 2006.

(m) *Net-Centric Operations and Warfare Reference Model (NCOW RM) V1.1*, 17 November.

(n) *Net-Centric Checklist, V2.1.3,* Office of the Assistant Secretary of Defense for Networks and Information Integration/Department of Defense Chief Information Officer, 12 May 2004.

(o) *A Modular Open Systems Approach (MOSA) to Acquisition, Version 2.0*, September 2004.

(p) DoD IT Standards Registry (DISR), http://disronline.disa.mil.

(q) *Net-Centric Attributes List,* Office of the Assistant Secretary of Defense for Networks and Information Integration/Department of Defense Chief Information Officer, June 2004.

(r) *Global Information Grid (GIG) Key Interface Profiles (KIPs) Framework (DRAFT)*, Version 0.95, 7 October 2005.

1.2 Purpose of this Document

This document is provides a high-level general overview of the Net-Centric Enterprise Solutions for Interoperability (NESI) to provide general awareness of NESI to a broad range of interested stakeholders.

1.3 NESI Overview

Net-Centric Enterprise Solutions for Interoperability (NESI) provides, for all phases of the acquisition of net-centric solutions, actionable guidance that meets DoD Network-Centric Warfare goals. The guidance in NESI is derived from the higher level, more abstract concepts provided in various directives, policies and mandates such as the *Net-Centric Operations and Warfare Reference Model* (*NCOW RM*) and the ASD(NII) *Net-Centric Checklist*, references (m) and (n), respectively. As currently structured, NESI guidance is captured in documents covering architecture, design and implementation; a compliance checklist; and a collaboration environment that includes a repository of guidance statements and code examples.

More specifically, NESI is a body of architectural and engineering knowledge that guides the design, implementation, maintenance, evolution, and use of the Information Technology (IT) portion of net-centric solutions for military application. NESI provides specific technical recommendations that a DoD organization can use as references. Stated another way, NESI serves as a reference set of compliant instantiations of these directives.

NESI is derived from a studied examination of enterprise-level needs and, more importantly, from the collective practical experience of recent and on-going program-level implementations. It is based on today's technologies and probable near-term technology developments. It describes the practical experience of system developers within the context of a minimal top-down technical framework. Most, if not all, of the guidance in NESI is in line with commercial best practices in the area of enterprise computing.

NESI applies to all phases of the acquisition process as defined in references (a) and (b) and applies to both new and legacy programs. NESI provides explicit counsel for building in net-centricity from the ground up and for migrating legacy systems to greater degrees of net-centricity.

NESI subsumes a number of references and directives; in particular, the Air Force *C2 Enterprise Technical Reference Architecture (C2ERA)*[1] and the Navy *Reusable Applications Integration and Development Standards (RAPIDS)*.[2] Initial authority for NESI is per the Memorandum of Agreement between Commander, Space and Naval Warfare Systems Command (SPAWAR), Navy PEO C4I & Space and the United States Air Force Electronic Systems Center, dated 22 December 2003, Subject: Cooperation Agreement for Net-Centric Solutions for Interoperability (NESI). The Defense Information Systems Agency (DISA) formally joined the NESI effort in 2006.

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[1] Air Force C2 Enterprise Technical Reference Architecture, v3.0-14, 1 December 2003.

[2] RAPIDS Reusable Application Integration and Development Standards, Navy PEO C4I & Space, December 2003 (DRAFT V1.5).

1.4 NESI Purpose

NESI has value to multiple audiences (see Section 1.11, Intended Audience, below). The key value of NESI to program-level management and engineering personnel across the DoD is to make informed architectural and engineering decisions in support of achieving enterprise-level objectives related to Network-Centric Warfare. In general, these enterprise-level objectives relate to broad-scale data interoperability and overall system flexibility. While these objectives occasionally compete with program-level objectives of meeting specific cost, schedule, and performance goals, it is anticipated that achieving these enterprise-level objectives will result in an overall long-term benefit to the DoD.

More specifically, NESI attempts to provide acquisition programs a practical means for addressing DoD Network-Centric Warfare policy, directives, mandates, and other guidance documentation, listed as references (a) through (r) above. NESI is not intended to replace existing policy, directives, and mandates, but rather helps to translate them into concrete actions for evaluation by program personnel. By considering the body of knowledge within NESI, an acquisition program is not guaranteed to be compliant with this direction, but program personnel should be better positioned to explain any deviation from it and consequently help programs pass Milestone reviews. By using NESI, program personnel and other stakeholders should have an increased level of confidence in the net-centricity of a specific program or set of programs.

NESI also lays the technical groundwork for developing an approach to assessing a program's degree of net-centricity within certain limitations. The most important contribution of NESI in this regard is to provide a framework for addressing specific topics that surround the often difficult trade-off decisions made among realizing various enterprise- and program-level objectives. (See Section 1.12, Intended Usage, for additional information).

1.5 Goals

Key NESI goals include the following:

- Promote realization of the net-centric aspects of the GIG architecture, per reference (g), through the evolution of legacy systems and the development of new systems that comply with DoD net-centric direction.

- Promote the consistent application of a sound technical approach to net-centricity based on a component-based[3] N-tier[4] framework for application development. (Note: this framework may be implemented in many different ways; e.g., with different infrastructure distribution strategies).

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[3] Component-based: A computing model in which an application is built from small binary objects or programs. Each object implements a specific function and is designed to operate easily with other components and applications. Partitioning systems into components allows for component sharing and reuse across multiple applications.

[4] N-tier: A computing model in which an application is partitioned into multiple software layers. Each layer uses dedicated services and provides specific functions. The N-tier model facilitates the development of flexible and reusable applications. By breaking up an application into tiers, developers only have to modify or add a specific layer in order to change the application.

- Promote the reuse of software components so that they can be composed easily into new mission capabilities with minimal development effort. NESI establishes a technical basis[5] that allows developers to leverage reuse opportunities.

- Promote enterprise integration and interoperability through the reuse of enterprise design patterns, well-defined public service interfaces, and loosely coupled[6] components. These are key elements to meet the criteria in reference (n).

- Provide a model for the distribution of infrastructure elements in which Enterprise Services are provided and managed across the enterprise by the NCES program[7] and individual programs share infrastructure resources in a Node-based[8] approach.

1.6 Vision

The vision for NESI is that it will be the definitive source of net-centric implementation guidance for the DoD. The knowledge expressed in NESI will be accurate, current, accessible, cover all pertinent technical areas, and be easy to maintain. In addition, NESI will provide flexible tools for using this knowledge to achieve shared objectives across diverse organizations.

1.7 Development Strategy

To achieve the NESI vision, the developers of NESI will, in coordination with the rest of the acquisition, research, and user communities (to include government and industry representatives) do the following:

- Define related terms and concepts

- Identify specific architectural and engineering knowledge at multiple levels of abstraction:
  - o Identify succinct, atomic, actionable guidance[9]
  - o Define the context for the guidance
  - o Identify, define, and develop examples
  - o Identify appropriate reference material

- Vet this knowledge across pertinent communities

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[5] In this context the term "technical basis" means the technical protocols, standards, etc., not the actual system components that might be part of a reuse support infrastructure.

[6] Loosely coupled: A computing model where application elements require a simple level of coordination and allow for flexible reconfiguration. Interconnection is often asynchronous and message-based.

[7] Defense Information Systems Agency, Net-Centric Enterprise Services (NCES) Technology Development Strategy, Version 2.3, 22 March 2004.

[8] For the purposes of this document, a Node is viewed as a collection of systems, applications, services, and other Nodes which results from the alignment of organizations, technologies, processes or functions. See *NESI Part 4: Node Guidance* for more details.

[9] The term "guidance" is used in the broadest sense to include best practices as well as mandates; "atomic" in this context means guidance that is about a single topic. This does not preclude the grouping of related guidance statements together nor the formulation of guidance of various degrees of abstraction.

- Identify tools to store, tag, sort, filter, and distribute this knowledge
- Maintain this knowledge
  - NESI will continue to evolve as the concept of net-centricity evolves
  - NESI will remain current with changes in DoD net-centric directives, mandates, and instructions

Individual pieces of guidance will also be tagged with such metadata as source, currency (i.e., effective dates), and perceived importance (by organization). Individual pieces of guidance will also be capable of being tagged by using communities for specific uses such as indicating the scope of application for a particular piece of guidance. Individual pieces of guidance will also be capable of being grouped arbitrarily into potentially overlapping sets, called perspectives, that group common topics together (such as security or data) for ease of reference.

1.8 Development Governance

A governing body consisting of representatives from participating DoD organizations oversees the evolution of NESI. This body sets priorities for the execution of specific aspects of the NESI development strategy described above. This body meets on a regular basis to review NESI development plans and progress and to ensure adequate configuration management and content distribution mechanisms are in place.

1.9 General Limitations

NESI cannot provide all of the technical guidance needed to achieve net-centricity, for the following reasons:

- Mature standards and accepted best practices do not yet exist for a number of areas that are critical to achieving desired enterprise objectives. A number of hard technical questions exist related to net-centricity that are not yet addressed or well understood given today's technologies (e.g., providing Quality of Service measures for Web services).

- NESI does not provide a "build to" specification. The size and complexity of the enterprise combined with the rapid rate of technology evolution preclude that level of detail.

- Program-specific implementation details must be analyzed within the context of each individual program. The guidance in NESI is not intended to apply uniformly to all contexts. NESI is meant to augment, not replace, traditional systems engineering at the program-level.

- NESI does not specify how to provision and deploy specific system components (e.g., services). Nor does it specify the use of specific commercial off-the-shelf (COTS) products. Acquisition managers make specific implementation choices (e.g., centralized versus distributed services and data, select specific COTS products) as appropriate within the enterprise framework as described in NESI.

- NESI does not attempt to predict the direction, progress, or capabilities of future technology.

- NESI does not address any of the processes or methodologies for developing systems (e.g., spiral development). This framework, however, is compatible with all commonly accepted methodologies and development models.

While NESI applies explicitly to solutions for Net-Centric Warfare, pieces of it may have applicability in a broader context.

1.10 Limitations of the Current Scope

This version of NESI does not address all of the problems of real-time computing, or of applications running on disconnected networks. The NESI strategy can be extended to cover these areas, and future versions of NESI may contain this guidance.

1.11 Intended Audience

The intended audience for this document is government and industry system and software engineers who are developing net-centric solutions as well as their associated program managers. Portions of NESI also pertain to contracting officers and end users.

1.12 Intended Usage

NESI can be used to architect and design net-centric solutions. As such, it can support a number of acquisition-related programmatic and engineering tasks:

- Prepare requirements documents

- Prepare various solicitation documents such as requests for proposals (RFPs) and statements of work (SOWs)

- Evaluate proposals

- Prepare contracts

- Prepare for general engineering reviews

- Prepare for design reviews

- Prepare for program reviews

- Perform program-level self assessments of net-centricity

- Perform enterprise-level net-centric assessments

- Prepare for program-level enterprise and application architecture reviews

In general, implementing NESI, especially in the area of assessing program net-centricity, is a Service-unique function. One potential approach is to use specific NESI guidance statements as the basis for a guided discussion between program personnel and assessment personnel. Another approach is to use NESI guidance statements to develop a program self-assessment mechanism.

While NESI can support all of these activities, it is not intended to be applied without judgment or specific program understanding.

1.13 Releasability Statement

This document has been cleared for public release by competent authority in accordance with DoD Directive 5230.9 and is granted *Distribution Statement A: Approved for public release; distribution is unlimited*. Obtain electronic copies of this document at the following site: http://nesipublic.spawar.navy.mil.

1.14 Vendor Neutrality

NESI documentation sometimes refers to specific vendors and their products in the context of examples and lists; however, NESI is vendor-neutral. Mentioning a vendor or product is not intended as an endorsement, nor is a lack of mention intended as a lack of endorsement.

Code examples typically use open-source products since NESI is built on the open-source philosophy. NESI accepts inputs from multiple sources so the examples tend to reflect whatever tools the contributor was using or knew best. However, the products described are not necessarily the best choice for every circumstance. Users are encouraged to analyze specific project requirements and choose tools accordingly. There is no need to obtain, or ask contractors to obtain, the open-source tools that appear as examples in this guide. Similarly, any lists of products or vendors are intended only as references or starting points, and not as a list of recommended or mandated options.

1.15 Disclaimer

Every effort has been made to make NESI documentation as complete and accurate as possible. Even with frequent updates, this documentation may not always immediately reflect the latest technology or guidance.

1.16 Contributions and Comments

NESI is an open-source project that will involve the entire development community. Anyone is welcome to contribute comments, corrections, or relevant knowledge to the guides via the Change Request tab on the NESI Public site, http://nesipublic.spawar.navy.mil, or via the following email address: nesi@spawar.navy.mil.

1.17 Collaboration Site

The Navy has established a collaboration site to support NESI community interaction. It is located at https://nesi.spawar.navy.mil (user registration required). Use this site for collaborative software development across distributed teams.

2 Introduction

The purpose of Network-Centric Warfare (NCW) is to increase combat effectiveness by effectively networking the warfighting enterprise.

Reference (n) provides direction to acquisition programs for implementing Network-Centric Warfare. NESI complements reference (n) with more specific guidance to help obtain approval during milestone reviews. Developing systems in accordance with these principles will make the warfighter's life easier.

NCW involves much more than physical connectivity. The "network" in NCW emphasizes a network of connections between people in the information and cognitive domains. NCW stresses the shared information and situational awareness that accelerates command and synchronized efforts in the battlespace.[10] Information systems that support NCW must exchange data seamlessly and act on a compatible understanding of the data's meaning. Specifically, they must do the following:

- Work with each other to produce coherent information, fusing many separate facts into a common picture of the battle space.

- Help users collaborate with each other to synchronize operations.

- Provide flexible information systems that can swiftly adapt to the information demands of a particular operational scenario. (This is necessary because information needs and what user collaborations must be supported are not always known in advance.)

Until now, most systems have not been built in a way that fulfills these requirements.

While the DoD is changing its usage model for information systems, various initiatives in the DoD are altering the way those information systems are produced and fielded. The public sector continually produces new technological opportunities, industry standards, and guidelines for our systems. Opportunities and challenges include the following:

- Modernize systems using new technological opportunities.

- Align with upcoming initiatives at a low cost.

- Be agile enough to reassemble capabilities to support new missions in a timely manner.

In summary, users need cohesive and flexible information systems. Ideally, they want a single, seamless system that accomplishes what they want now and changes quickly to provide what they want tomorrow. The goal of net-centricity is to deliver systems that meet these requirements.

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[10] Department of Defense, Office of Force Transformation, *Network-Centric Warfare: Creating a Decisive Warfighting Advantage*, Winter 2003,
http://www.oft.osd.mil/library/library_files/document_318_NCW_GateFold-Pages.pdf

2.1 NESI Product Overview

The technical principles of NESI are widely used in industry; best-of-breed companies use them in the ways described here. NESI is structured into a set of guidance products that program managers and contractors should use to achieve net-centric interoperability within their Programs of Record (PORs). The guidance should be followed during all phases of a program's lifecycle. The general guidance should be considered in all aspects of "doing business," and there are also specific examples of language that may be incorporated into program acquisition and capabilities documents (e.g., JCIDS documents, acquisition strategies and contracting artifacts). This section describes the current products and their intended use and audience. Each audience may tailor the NESI products to their needs. Readers should use the descriptions below to choose the guidance documents most helpful for their particular program.

2.1.1 Part 1: Overview

Part 1 presents government program managers and DoD contractors with a technical implementation framework for building information systems that conform to the net-centric environment. This framework is based on an enterprise architecture and technical implementation guidance. The architecture provides an enterprise structure and context for building mission capabilities. Use Part 1 in all phases of the acquisition process.

2.1.2 Part 2: ASD(NII) Checklist Guidance

Part 2 guidance is aligned with reference (n). It is intended for managers of new programs or programs that are undergoing a transformation or major upgrade. Use Part 2 especially in the pre-systems acquisition and systems acquisition phases. Reference (n) uses net-centric design precepts called **tenets** to guide the move into the net-centric environment. NESI provides specific technical direction for satisfying reference (n). Note that some tenets address doctrinal or procedural requirements; this guidance does not address those areas.

2.1.3 Part 3: Migration Guidance

Part 3 guidance is intended for the program managers and DoD contractors of existing programs. These programs use pre-planned product improvement or maintenance funds to incorporate net-centric characteristics. This guidance presents a strategy to migrate deployed applications to the net-centric paradigm during the maintenance phase. It describes how to implement a phased software migration strategy to deliver net-centric capability and to fulfill current contractual and program maintenance obligations. Use Part 3 especially in the sustainment phase.

2.1.4 Part 4: Node Guidance

Part 4 helps government program managers, system engineers, and DoD contractors who develop applications and systems to conform to NESI Node guidance. This guidance specifies the criteria for building Nodes and their associated infrastructure in the net-centric environment. A Node is a collection of Components (i.e., systems, applications, services, and other Nodes) which results from the alignment of organizations, technologies, processes, or functions. Potential alignment attributes include management, acquisition, mission, technological,

sustainment, spatial, or temporal. A Node enables the sharing of common approaches that support net-centric interoperability. Use Part 4 especially in the systems acquisition phase.

2.1.5 Part 5: Developer Guidance

Part 5 provides developers with style guidance, detailed programming guidelines, reference software code, and open-source library references. It is intended for developers building applications, services, and components for use in the net-centric environment and is particularly useful during the system acquisition phase.

The guidance has two components:

- A standalone introductory document for developers and non-developers

- A Web browser-based HTML package containing detailed software development guidance, including code samples, examples, good coding practices, and lessons learned

2.1.6 Part 6: Acquisition Guidance

Part 6 is intended for program managers and DoD contractors. It outlines the acquisition process and system/product requirements appropriate to achieving NESI compliance. It relates the steps of the System Acquisition Framework,[11] from concept refinement to post-contract award, to NESI tenets and principles. Use Part 6 during pre-systems acquisition and systems acquisition.

2.2 Background

Although C2ERA and RAPIDS form the core of the NESI effort, NESI incorporates additional service-specific supportive guidance:

- Air Force Node Information Services (NIS) guidance for building loosely coupled information services using Web services technology[12]

- Air Force XML implementation guidance for the construction and use of XML for information interchange[13]

- Navy FORCEnet Architecture and Standards providing Navy-specific direction for migrating toward the DoD Global Information Grid (GIG)[14]

- Navy Open Architecture[15]

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[11] Reference (b)

[12] Department of the Air Force, Headquarters Electronic Systems Center, *Node Information Services - Guidance for Implementing Web Services on C2 Nodes*, Version 3.2, 2 September 2003, **http://herbb.hanscom.af.mil/tbbs/r582/nodeNode_information_services___3_2.doc**.

[13] Department of the Air Force, Headquarters Electronic Systems Center, *Extensible Markup Language (XML) Implementation Guidance*, C2 Enterprise Integration, 16 April 2002, **http://herbb.hanscom.af.mil/C2ED_new/index.asp**.

[14] Department of the Navy, Office of the Chief Engineer, SPAWAR 05, *FORCEnet Architecture and Standards, Volumes I and II*, V1.4, 30 April 2004.

[15] Department of the Navy, *Open Architecture*, Volumes 1-5, 2003.

- *DON XML Developer's Guide* and *DON XML Policy*[16]

2.3 Evolution

NESI guidance will evolve along with our understanding of net-centricity. The specific details of the net-centric and enterprise capabilities referenced in these guidance documents may change.

Continuous monitoring of emerging technologies, policies, and practices guides the evolution of NESI. This evolving process is depicted in Figure 1 below.
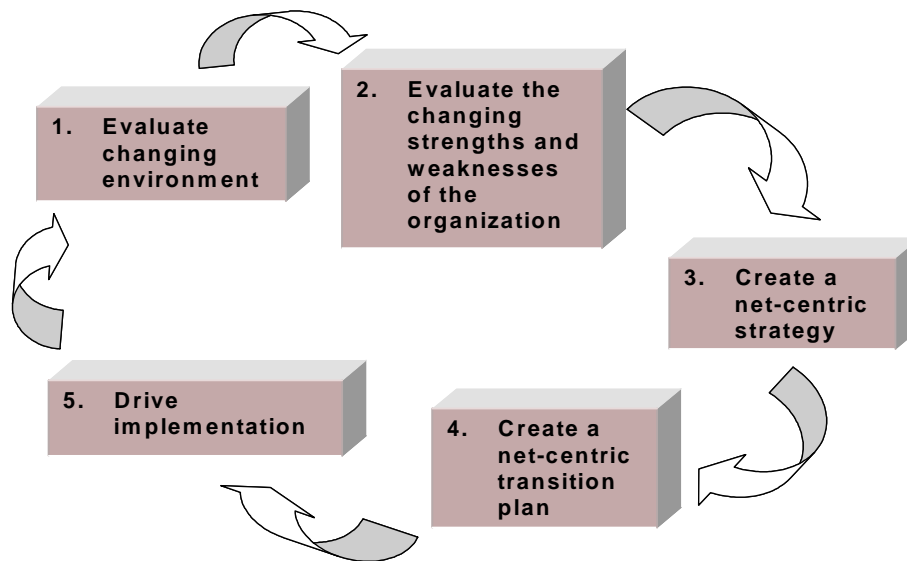
Figure 1: NESI Guidance Process

The NESI approach unravels functions embedded within current systems to make data and capabilities more accessible. Implicit in this approach is the potential need for retraining program managers, developers, integrators, and system administrators.

This method requires the following:

- New approaches to managing mission capabilities as services
- New monitoring tools and techniques
- New testing and deployment approaches
- New hardware and acquisition planning
- New user support functions

Recognizing the breadth and depth of this change—which represents a general rethinking of system design—is fundamental to the task of evaluating current DoD organization. The outcome of the process will be alignment with the operational shift from TPED (Task, Process, Exploit, Disseminate) toward TPPU (Task, Post, Process, Use).

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[16] Department of the Navy, *XML Developer's Guide* version 1.0, 29 October 2001; XML Policy, 13 December 2001.

3 Relating DoD Net-Centric Efforts to NESI

The following subsections describe how NESI relates to other DoD net-centric efforts:

- ASD(NII) Net-Centric Attributes
- Net-Centric Operations and Warfare Reference Model (NCOW RM)
- GIG Architecture
- KIP Framework and specific KIPs
- NCES
- DoD Data Strategy

3.1 ASD(NII) Net-Centric Attributes

ASD(NII)/DoD CIO has published a matrix of technical attributes, reference (q), that net-centric applications should exhibit. That matrix serves as the framework for NESI guidance. *NESI Part 2: ASD(NII) Checklist Guidance* and *NESI Part 3: Migration Guidance* map each guidance statement to these attributes through a set of enterprise technology objectives, as described below.

Table 1: ASD(NII) Net-Centric Attributes

Attribute	Description	Metric
Internet Protocol (IP)	Data packets routed across network, not switched via dedicated circuits.	IP as the convergence layer
Secure and available communications	Encrypted initially for core network; goal is edge-to-edge encryption and hardened against denial of service.	Black transport layer
Only handle information once (OHIO)	Data posted by authoritative sources and visible, available, usable to accelerate decision making.	Reuse of existing data repositories
Post in parallel	Business process owners make their data available on the net as soon as it is created.	Data tagged and posted before processing
Smart pull (vice smart push)	Applications encourage discovery; users can pull data directly from the net or use value-added discovery services.	Data stored in public space and advertised (tagged) for discovery
Data centric	Data separate from applications; apps talk to each other by posting data.	Metadata registered in DoD Metadata Registry
Application diversity	Users can pull multiple apps to access same data or choose same app (e.g., for collaboration).	Apps posted to net and tagged for discovery

Attribute	Description	Metric
Assured sharing	Trusted accessibility to net resources (data, services, apps, people, collaborative environment, etc.).	Access assured for authorized users; denied for unauthorized users
Quality of service	Data timeliness, accuracy, completeness, integrity, and ease of use.	Net-ready key performance parameter

To help focus development and maintenance actions in support of these attributes, NESI analyzed the ASD(NII) Net-Centric Attributes List and derived the following concrete and engineering-oriented enterprise objectives.

Table 2: NESI Enterprise Technology Objectives

Technology Objective	Description	Derived from ASD(NII) Net-Centric Attributes
Capability on demand	Delivery of and/or access to capabilities (data, applications, connectivity) incrementally and as needed, on demand, and controlled by user clearance. Examples: • Making available new data sources in different security domains. • Downloading needed applications without disrupting current operations. • Reallocating communication bandwidth to meet today's operational needs and providing those needs to another organization tomorrow.	• Application diversity • Assured sharing • Data centric • Internet Protocol(IP) • Quality of service • Secure and available communications
Distributed operations	Enable Battle-Force commanders: • Gain immediate access to essential expertise. • Leverage off-board resources and expertise. • Coordinate diverse aspects of operations with timely, reliable resources (i.e., trusted, remote access to collaboration environments for planning and data exchange). • Access reliable services to coordinate synchronized operations.	• Assured sharing • Internet Protocol (IP) • Quality of service • Secure and available communications

Technology Objective	Description	Derived from ASD(NII) Net-Centric Attributes
Customized applications	Applications can be tailored on a continuing basis to meet current Rules of Engagement (ROE) and readjusted to meet tomorrow's needs. For example, users can choose between a collaborative environment that allows them to access and share full-frame images or an environment for limited bandwidth communications, depending on the current need. They can adjust geographic displays to access archives of high-resolution terrain for specific, changing areas of interest.	• Application diversity • Data centric • Post in parallel • Smart pull (vice smart push)
Multi-user access	Multiple users can simultaneously access data stores, use applications, and analyze and direct operations. Examples: • Operators can develop and play back multiple ingress/egress scenarios to accomplish more comprehensive, faster mission planning. • Multiple users can update data archives without overwriting each other. • Operators can use the same situational awareness picture.	• Application diversity • Assured sharing • Data centric • Only handle information once (OHIO) • Post in parallel • Smart pull (vice smart push)
Customized delivery	Smart push and pull of data reduces overload and provides the requested data to operators when they need it. Tailored discovery, publish, and subscribe capabilities allow operators to register for specific data and services in specific timeframes. For example, operators can request track updates every four minutes. They can also request real-time data feeds that stream onto a non-real-time display for specific data types at specific times.	• Data centric • Post in parallel • Quality of service • Smart pull (vice smart push)

Technology Objective	Description	Derived from ASD(NII) Net-Centric Attributes
Assured sharing	Consistent authentication over the network provides trusted accessibility to resources such as data, services, applications, people, and collaborative environments. Examples: • Operators can access their data archives from diverse locations and share specific data as needed. • Essential expertise is available collaboratively. • Access to unique applications can be provided with reduced risk. • Secure access can be permitted easily and quickly.	• Assured sharing • Quality of service • Secure and available communications
Incremental upgrade	Certain capabilities can be modernized without impacting other capabilities. For example, developers can upgrade the display stations and software without changing how the application is used or replacing the on-board servers. They can upgrade databases without replacing applications that access the data.	• Application diversity • Quality of service
Data exchange	Operators can move data between applications easily and without losing data or capabilities. Data may carry security labels allowing for its exchange with partners operating at coalition or multinational releasable security levels. For example, multiple applications can access a single data archive. Users can display maps identically on any display system that has access to the underlying capabilities.	• Application diversity • Data centric • Only handle information once (OHIO) • Post in parallel • Smart pull (vice smart push)

3.2 Relationship to NCOW Reference Model

The *Net-Centric Operations and Warfare Reference Model*, reference (m), describes the DoD enterprise aspects of an objective NCOW information environment for the GIG.

- Provides a common, enterprise-level reference model for the DoD enterprise architecture, and a reference for acquisition programs to use in focusing and gaining net-centric support through the GIG.

- Enables a shared perspective of enterprise information environment operations.

- Helps decision-makers promote enterprise-wide unity of effort.

The goal is to have a uniform, DoD-wide reference for program development and oversight. Individual and enterprise programs should use it to address all net-centric IT-related issues in a consistent, coherent, and comprehensive manner.

NESI provides the technical guidance and enterprise design patterns for building net-centric capabilities as services and components that align to the NCOW RM. Within NESI, the combination of NCES and Nodes implement the NCOW RM requirements. The NCOW RM is part of the GIG Architecture described above. Compliance with the NCOW RM is one of four elements of the Net-Ready Key Performance Parameter (NR-KPP) and is assessed within the JCIDS acquisition process. Full realization of the DoD net-centric vision obligates GIG Nodes to implement portions of the NCOW RM.
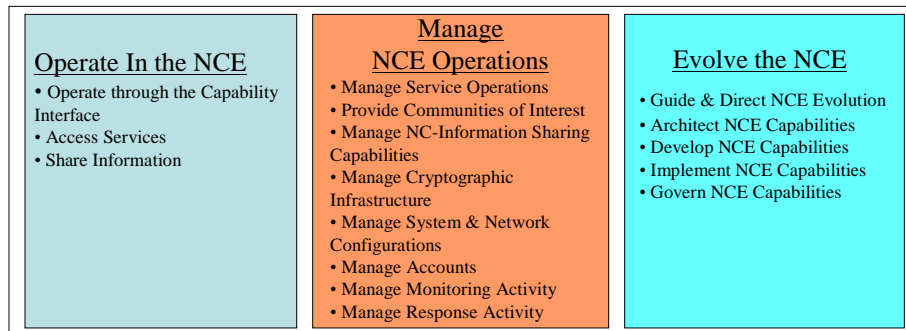
NESI provides the technical guidance and enterprise design patterns for building net-centric capabilities as services and components that align to the NCOW RM, and NESI guidance is designed to promote compliance. Following the guidance will help ensure NCOW RM compliance needed for NR-KPP assessment.

The NCOW RM is described using DoDAF architectural views. The model's operational view (OV) products are most fully described, and the system view (SV) products provide a high level view of the GIG, illustrating the concept of a GIG-level enterprise service infrastructure. The model reflects other DoD strategies and guidance, such as the DoD Data Strategy and the provisioning and use of the GIG Enterprise Services (GES) and Net-Centric Enterprise Services (NCES).

Figure 2 below shows the three top level NCOW RM activity models from Version 1.1 (which is substantially different than the earlier Version 1.0). Performance of these activities is a shared obligation. Some of the activities would typically be performed by DISA in provisioning the NCES, some would be done by the Node in providing and operating the local infrastructure, and some by the programs as a matter of development and system operation. Each of these high level activities is further decomposed within the full model, as shown in Figure 3 below. The full NCOW RM is viewable at https://disain.disa.mil/ncow/ncow_rm_v1_1.htm; the home page for both the NCOW RM and GIG Architectures is https://disain.disa.mil/ncow/gigv2/index.htm (user registration required).

NCOW RM V1.1 Final Activity Models

- *Operate in the Net-Centric Environment* - Basic Operational Model to be used by everyone.
- *Manage NCE Operations* – addresses NetOps needs.
- *Evolve the NCE* – addresses Enterprise Lifecycle Management needs (other than operations).

Operate In the NCE
• Operate through the Capability Interface
• Access Services
• Share Information

Manage NCE Operations
• Manage Service Operations
• Provide Communities of Interest
• Manage NC-Information Sharing Capabilities
• Manage Cryptographic Infrastructure
• Manage System & Network Configurations
• Manage Accounts
• Manage Monitoring Activity
• Manage Response Activity

Evolve the NCE
• Guide & Direct NCE Evolution
• Architect NCE Capabilities
• Develop NCE Capabilities
• Implement NCE Capabilities
• Govern NCE Capabilities

Figure 2. NCOW RM V1.1 Activity Models
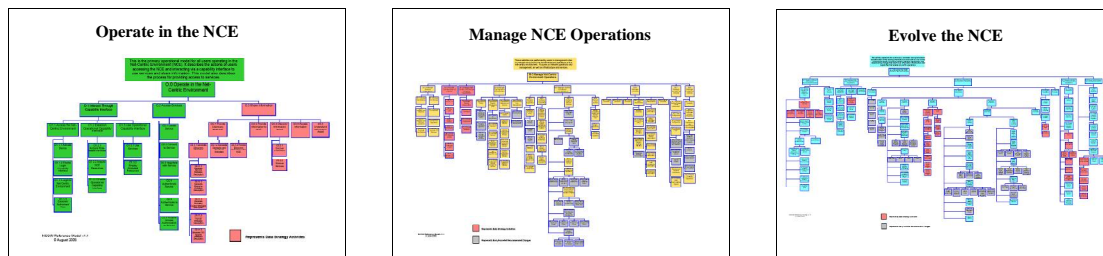
Figure 3. NCOW RM Activity Model Decompositions

The JCIDS acquisition process is the enforcement mechanism for compliance with the NCOW RM, as defined in references (l) and (e), CJCSI 6212.01D and DoDI 4630.8, respectively. Programs that do not sufficiently address compliance risk their JCIDS Milestone Decision Authority (MDA) approval.

3.3 Relationship to GIG Architecture

The GIG architecture describes the basic, high level architecture for the GIG. It is an integrated architecture consisting of operational (OV), systems (SV), technical views (TV) and all-views (AV) in accordance with the DoDAF model. It provides a common lexicon and defines a basic infrastructure for the performance of information exchanges among Nodes using the GIG Enterprise Services (GES) and the Net-Centric Enterprise Services (NCES). The GIG

Architecture can be viewed https://disain.disa.mil/ncow/gigv2/index.htm; the home page for both the GIG architecture and NCOW RM is https://disain.disa.mil/ncow.html (user registration required).

NESI provides implementation guidance for achieving interoperability within the GIG.

3.3.1 Relationship to Key Interface Profiles (KIPs)

Key Interface Profiles (KIPs) are used to specify key interfaces to the GIG. Compliance with the relevant KIPs is a Net-Ready Key Performance Parameter (NR-KPP) which is assessed at JCIDS milestone reviews. Acquisition programs are required by reference (l) to comply with the relevant KIP interfaces. The NESI Node concept facilitates compliance with the KIPs by providing KIP-compliant infrastructure and services, rather than putting the entire burden on the individual programs.[17]

The KIPs are currently in a mixed state of definition. Originally, there were 17 Key Interface Profiles (KIPs).

1. Logical Networks to Defense Information Systems Network (DISN) Transport Backbone

2. Space to Terrestrial Interface

3. Joint Task Force (JTF) to Coalition Forces (currently limited to addressing required capabilities for the Combined Enterprise Regional Information System or CENTRIXS)

4. JTF Component to JTF Headquarters

5. Standardized Tactical Entry Point (STEP)/Teleport System

6. Joint Interconnection Service

7. DISN Service Delivery Point

8. Secure Enclave to Service Delivery Point

9. Application Servers to Database Servers

10. Client to Server

11. Application to Common Operating Environment (COE)/Common Computing Platform (CCP)

12. End System to Public Key Infrastructure (PKI)

13. Management Systems to Integrated Management Systems

14. Management Systems to Managed Systems

15. Information Dissemination Management (IDM) to Distribution Infrastructure

16. Information Services to IDM Infrastructure

17. Applications to Shared Data

The KIPs are now being reformed according to a KIP Framework (draft) shown in Figure 4.

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[17] KIPs interfaces cover a wide range of functionality. Only those relevant to a particular node need be implemented.
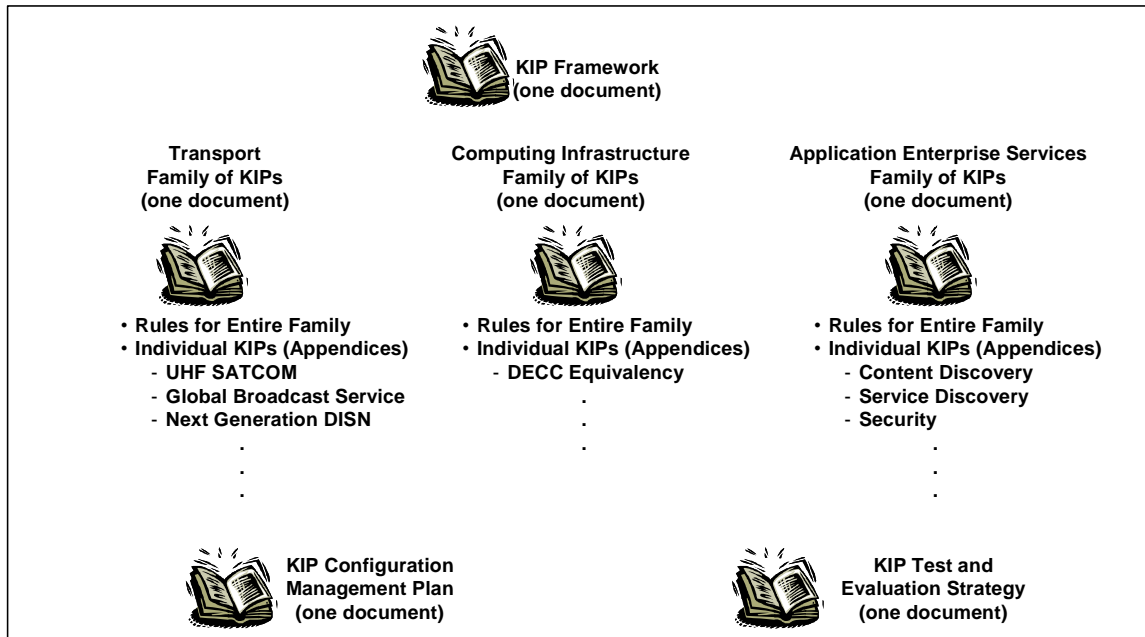
Figure 4. KIP Taxonomy

NESI provides guidance that helps programs comply with the KIPs. NESI also identifies some implementation issues, such as the federation of services and disconnected operations, and provides guidance where available.

3.3.2 Relationship to GES and NCES

Services are being defined for provision and use across the entire scope of the GIG; collectively, these are the GIG Enterprise Services (GES). A subset of these, called the Net-Centric Enterprise Services (NCES), include both fundamental enabling services needed to support the DoD net-centric goals and services that are common to communities of users or are utilitarian. The fundamental services for achieving net-centric goals are called the Core Enterprise Services (CES). The CES services are at various states of definition, piloting, and rollout. The common and utilitarian services are called Community of Interest (COI) services. This document focuses on the CES services as basic enablers of interoperability between GIG Nodes.

The Defense Information Systems Agency (DISA) is managing CES development as an agent for ASD(NII). Recognizing that there are complex interdependencies between elements of the CES, services development has been organized into product lines, as shown in Figure 9.

There is an NCES Pilot Participants Guide for the NIPRNET, developed as part of an Early Adopters effort, which describes how to participate in enterprise service pilots. For most sites, piloting would probably be done through a development, integration, and test cycle.
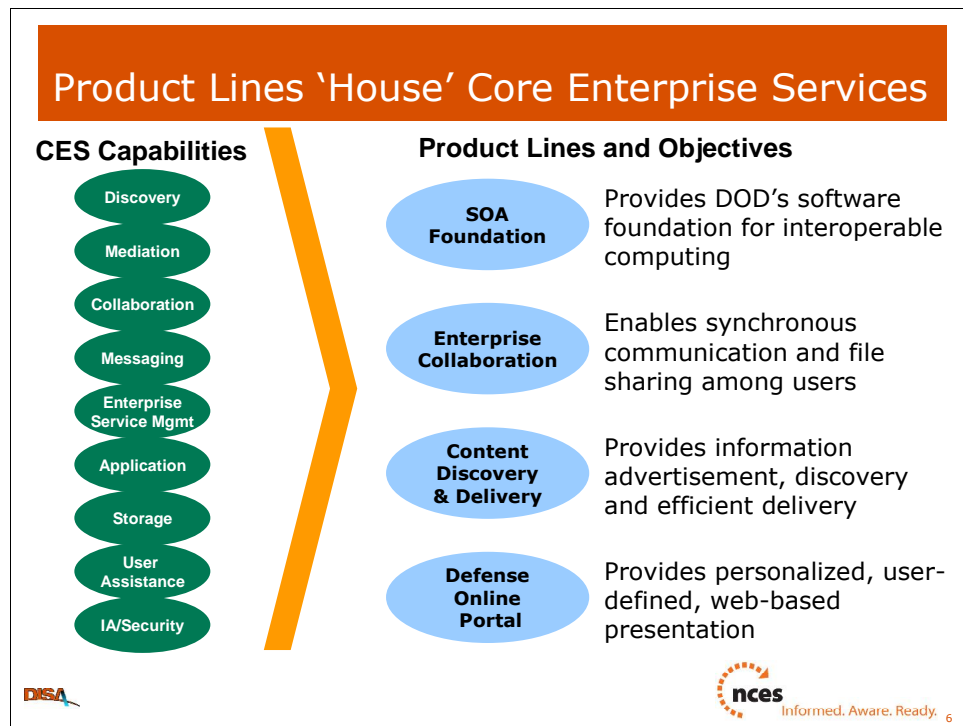
Figure 5. Organization of CES into Product Lines

The NCES and GES home pages are available through the Defense Online Portal at http://dol.dod.mil/ (user registration required).

NESI provides guidance applicable to coordinating and implementing services in alignment with NCES efforts.

3.4 Relationship to the DoD Net-Centric Data Strategy

The DoD has developed a DoD Net-Centric Data Strategy, along with associated policies and guidance. NESI contains guidance which addresses data or information engineering. Data engineering is as much a social and cultural challenge as it is a technical challenge. It is not a stand-alone activity. Community of Interest (COI) forums have the task of data engineering, and the DoD Metadata Registry (DMR) is the primary tool for managing data engineering across the GIG. DMR instances exists on the NIPRNET, SIPRNET, and JWICS networks.

4 NESI Guidance

Today there is no single, comprehensive technology deployment suitable for the entire DoD Enterprise. The complexity of the enterprise makes centralized implementation impractical. Its survivability requires independent, redundant, loosely-coupled entities.

The core technical concept of net-centricity is a completely secure network that is accessible worldwide. The network must deliver messages in a timely manner, such that the application or human who receives them can make decisions appropriately. The messages are either for services ("*Do something*") or for information ("*Tell me what I need to know*").

The net-centric vision needs to be concrete and explicit so that systems can implement it. Both legacy and new applications need simple, transparent, robust methods to acquire and share information across traditional system, service, and community boundaries.

NESI contributes to this vision by providing implementation guidance for building solutions to satisfy this vision. These solutions must meet the requirements specified in reference (n).

4.1 Information Interoperability

Net-centricity requires applications to share information with each other. To do this, applications must be able to exchange data and to agree on its meaning.

The first part requires access to data. That is, one application must be able to obtain data provided by another. NESI facilitates this by providing a least-common-denominator data access mechanism that all applications can use. This removes arbitrary implementation barriers to data exchange. NESI also includes guidance for adding customizability to applications, including "on-the-fly" reconfiguration.

The second part requires a *semantic match* between users and developers. That is, users and developers must be able to determine whether the data they receive is suitable for their purpose, and they must be able to cope with any *representation mismatch*. For example, if the source application provides volume measurements in gallons, but the receiving application requires liters, then a translation function must be applied. NESI does not directly address semantics at this time. The necessary shared understanding will be supported by common vocabularies developed by Communities of Interest.

4.2 Communities of Interest

NESI provides significant guidance for building systems that support Communities of Interest (COIs). A COI is a collaborative group of users who exchange information for their shared goals, interests, missions, or business processes. The success of this exchange depends on a shared vocabulary.[18] Within NESI, COIs have the following properties:

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[18] Reference (i), http://www.dod.gov/nii/org/cio/doc/Net-Centric-Data-Strategy-2003-05-092.pdf

- A COI is a group of people who share a common vocabulary. There is typically a deliberate effort to produce this community vocabulary.

- A COI may be institutional, expedient, functional, or cross-domain.

- A COI may be a subset of another COI.

- A COI always encompasses more than one system or Node. A system is a source of data and/or capability, and often participates in more than one COI.

- A COI typically encompasses more than one organization.

4.3 NESI Elements

NESI organizes the enterprise into three elements:

- **Enterprise Services** provide enterprise-wide capabilities to link Nodes, services, applications, and components.

- **Nodes** provide local infrastructure to support local services, applications, and components.

- **Services, Applications, and Components** integrate with the Node infrastructure to provide mission capabilities the warfighters need.

NESI supports an N-tier architecture including client, presentation, middle, and data tiers. NESI relies upon the Net-Centric Enterprise Services (NCES) program (see Section 4.5). The combination of NCES and NESI yields an open-standards architecture that allows the enterprise to encapsulate the elements of existing or new systems. The elements plug together seamlessly and can be upgraded and expanded more easily.

The NCES architecture does *not* currently provide detailed guidance for developing systems or applications to support COIs. NESI complements NCES by expanding the guidance for COIs and for the infrastructure required to build mission applications that integrate into COIs and the enterprise.

The DoD Enterprise includes software components delivered by different organizations on different schedules. All components, however, are organized around the architecture shown in the figure below. Figure 6 shows the types of components that coexist in the enterprise and support each other.
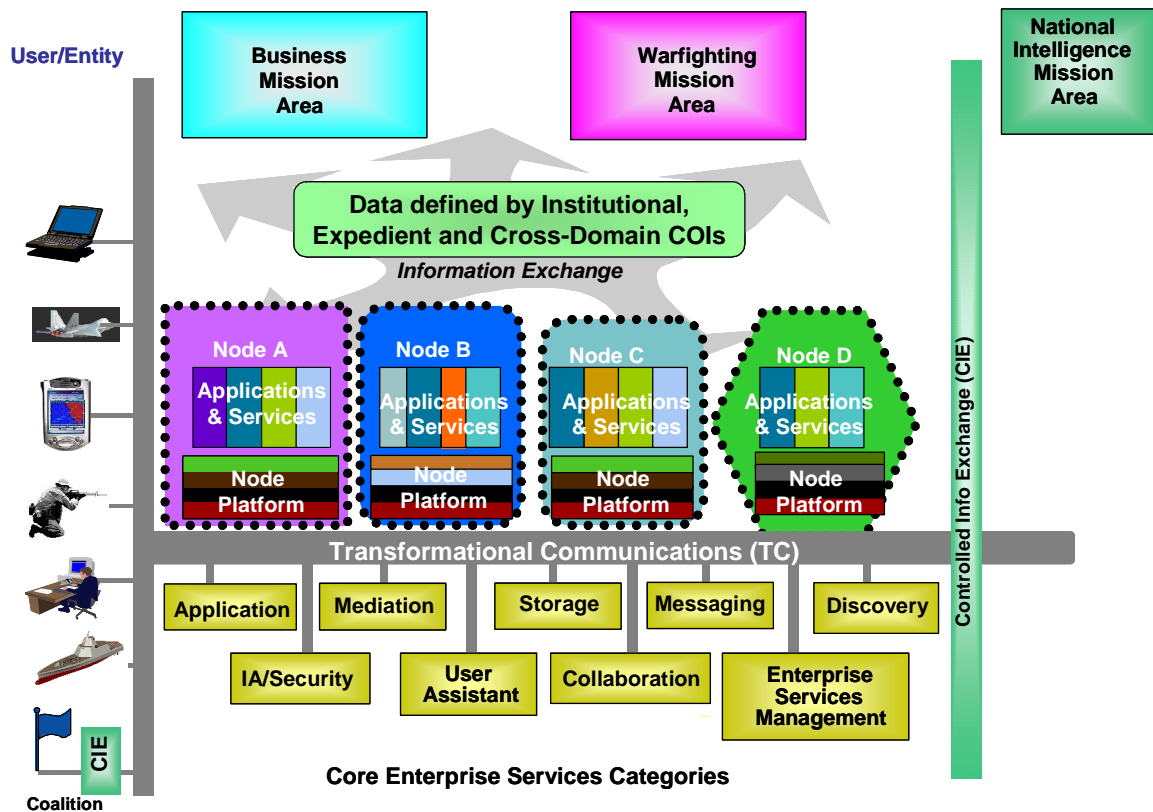
Figure 6. DoD Net-Centric Enterprise

At the top of Figure 6 are three basic DoD domains: business operations, warfighting and intelligence. COIs that share data are formed within and across these domains.

The Node provides the infrastructure that supports COIs. The figure shows several Node instances which communicate using the GIG. Nodes provide or make use of core services (shown at the bottom of the figure) to support inter-Node activities such as messaging.

NCES services will not meet all internal needs of Nodes and COIs. The local Node infrastructure provides services for applications and users within the COI and Node.
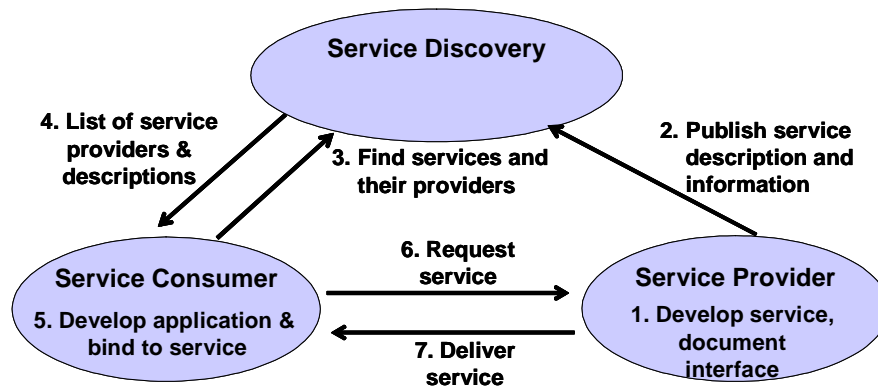
4.4 Service-Oriented Architecture

A Service Oriented Architecture (SOA) best fulfills the requirements of a net-centric environment. Multiple clients and other services can access mission application functionality as a set of services. These services are layered on separate Node-based and enterprise-wide infrastructures.

In a Service Oriented Architecture there are three roles (see Figure 7):

- **Service Provider**: Makes a service available, including the service interface. A service provider publishes a service interface and may provide additional service metadata in a service registry.

- **Service Consumer**: Invokes and uses a service according to rules in the service interface.

- **Service Discovery**: Provides descriptive information about a service as metadata, enabling the lookup and discovery of services.
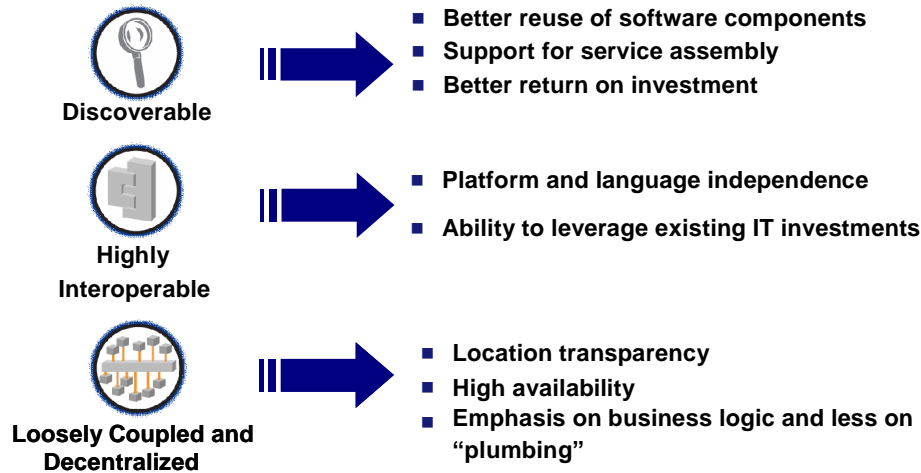

Figure 7. Service-Oriented Architecture

4.4.1 SOA Benefits

The SOA approach has two key benefits:

- It promotes flexibility and reuse. This enables developers to compose complex software systems from clearly defined, implementation-neutral interfaces rather than through brittle implementation mechanisms such as tightly coupled, highly integrated applications or APIs.

- It isolates the specifics of data implementation from the service interface, allowing systems to evolve their internal implementation without impacting other systems.

In an SOA, business functions are provided as services one or more clients may invoke. Services expose business functions through well-defined interfaces that separate implementation from interface. Services are designed to be highly interoperable, loosely coupled, decentralized, and discoverable across the enterprise. This approach provides significant benefits, as shown in Figure 8.

Discoverable

- Better reuse of software components
- Support for service assembly
- Better return on investment

Highly Interoperable

- Platform and language independence
- Ability to leverage existing IT investments

Loosely Coupled and Decentralized

- Location transparency
- High availability
- Emphasis on business logic and less on "plumbing"

Figure 8: Benefits of an SOA and Web Services

4.4.2 Service Interfaces

Service interfaces have the following properties:

- They must be defined independently of implementations.

- New interface versions require strict configuration management so that service consumers can migrate independently.

- Newer versions of services must honor existing interface contracts.

- The version sequence of the interface should be different than the version sequence of the code and data implementation, and it should be able to evolve independently.

4.5 Enterprise Services

Enterprise services and Nodes provide infrastructure capabilities that underlie the SOA paradigm.

NCES defines a set of core enterprise services. NCES services are the set of net-centric utilities that the DoD and Defense Information Systems Agency (DISA) defined to enable secure, reliable, timely, and interoperable information exchange.

The GIG architecture allows for additional domain and mission-related services, called COI services, which extend the enterprise beyond NCES. Services provided by Nodes will generally be developed as COI services.

NESI guidance is primarily intended for developers of systems that provide and use COI services and use NCES services.

4.5.1 Net-Centric Enterprise Services[19]

The Net-Centric Core Enterprise Services (NCES)[20] program will provide enterprise-level Information Technology (IT) services and infrastructure components for the DoD GIG. The net-centric enterprise relies on the NCES infrastructure. NCES in turn relies on GIG transport services such as the Defense Information System Network (DISN) and tactical communications systems. While NCES relies upon the GIG transport services, visibility into transport details is not an inherent component of NCES.

Many of the NCES services referenced in NESI guidance are evolving. The implementer should use these services where available. Where they are not yet available, the developer should provide an application-specific, Nodal, or COI implementation based on the NCES interface definition. The developer should design the implementation based on best commercial practice so that it is straightforward to replace it with the NCES implementation of the service, when that is deployed.

4.6 Nodes

This section summarizes the key principles and characteristics of Nodes in the NESI context. See *NESI Part 4: Node Guidance* for details on Nodes.

A Node is a collection of Components (i.e., systems, applications, services, and other Nodes) which results from the alignment of organizations, technologies, process, or functions. Potential alignment attributes include management, acquisition, mission, technological, sustainment, spatial, or temporal. A Node enables the sharing of common approaches that support net-centric interoperability. As a concept, Nodes may not be defined in terms of a concrete set of Components or size.

Nodes represent a departure from the past "stovepipe" acquisition and development of single systems with tightly integrated infrastructure and mission function. Factors such as physical environments and employment concepts directly influence a Node's scope, and boundaries can vary widely. Nodes typically contain systems, applications, and components that have similar missions and locality. However, Nodes are not limited to supporting similar missions and can be geographically distributed or aligned across other parameters.

Common needs as well as external interoperability requirements drive the definition of a Node's infrastructure, services, components, and applications. *NESI Part 4: Node Guidance* focuses on identifying a set of guidance for achieving integration and interoperability of Nodes within the GIG; additional Part 4 guidance is meant for those in a position to influence decisions regarding infrastructure and services provided by the Node for shared use by the systems within the Node. With respect to the GIG, the principal question addressed is, "*What and how should a Node implement the shared infrastructure needed to achieve the DoD vision of broad integration and interoperability across the GIG, on behalf of systems within the Node, and in accordance with DoD policy and direction?*" Part 4 focuses on guidance for achieving integration and

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[19] Net-Centric Enterprise Services, https://ges.dod.mil/.

[20] *Capability Development Document for Net-Centric Enterprise Services*, Draft Version 0.7.15.2, 9 April 2004.

interoperability in this context without excluding additional capabilities that may be needed to satisfy specific operational needs.

The guidance is applicable to *information systems*, such as those for command and control or intelligence. Nodes can include components such as Web servers, portal servers, application servers, and database servers. Nodes share information with other Nodes connected to the enterprise network according to COI-defined standards for information content, structure, and format implemented by the services, applications, and components within the Node. Some Nodes may require continued (though probably degraded) operation even when disconnected from the GIG and must therefore provide local services while maintaining interoperability with the enterprise.

Figure 9, below, depicts a notional DoD enterprise based on Nodes.
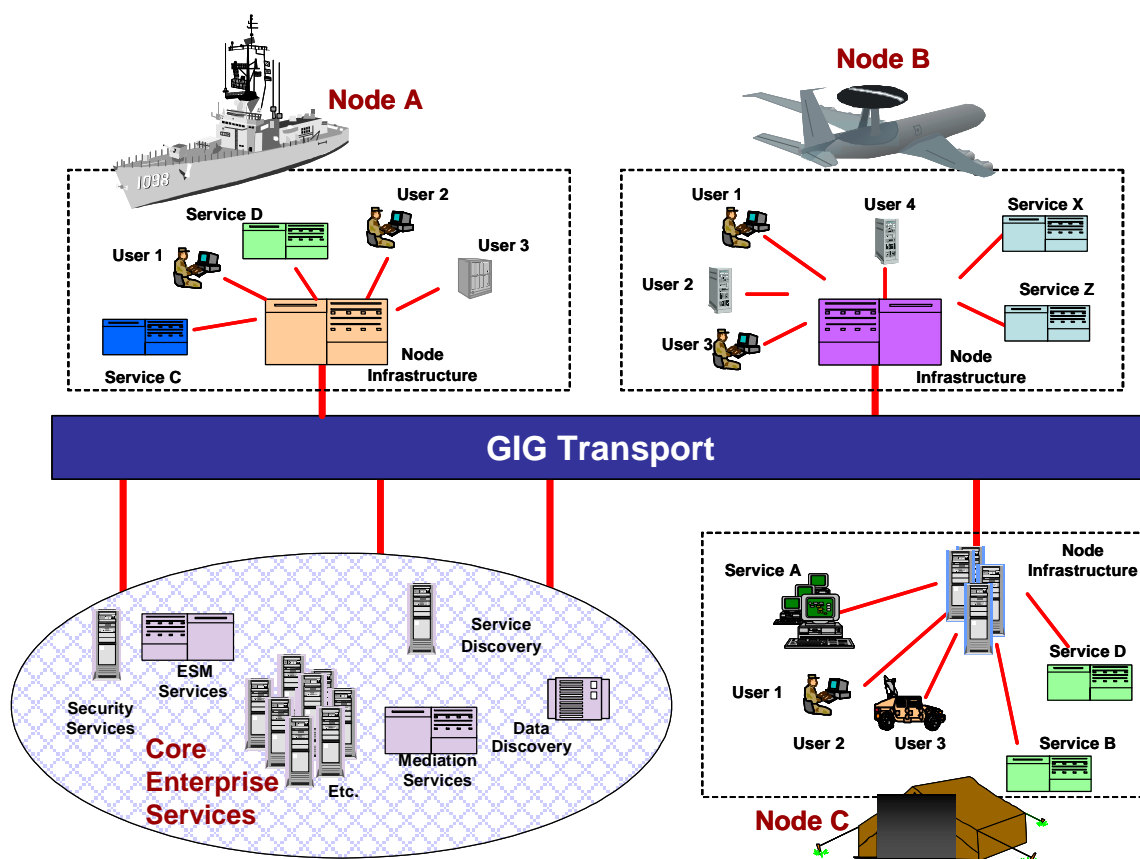
Figure 9. Nodes in the Enterprise

The net-centric enterprise comprises a set of Nodes, where each Node comprises a set of mission functions and services implemented on a common infrastructure. The enterprise can be managed as a collection of Nodes without concern for the intra-Node implementation details.

Nodes optimize their infrastructure and services to support their missions. The enterprise is optimized to provide continuity, consistency, interoperability, and persistence across the enterprise.